

**APPENDIX E: TERESA: TOXICOLOGICAL EVALUATION OF REALISTIC
EMISSIONS OF SOURCE AEROSOLS**

**Presented by Ronald E. Wyzga, Air Quality, Health and
Risk Electric Power Research Institute**

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**TERESA: Toxicological
Evaluation of Realistic
Emissions of Source
Aerosols**

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Overview

- Evaluate toxicity of *secondary* coal combustion emissions at multiple power plants in the U.S.
- Conduct extensive chemical characterization.
- Assess multiple toxicological endpoints in normal and susceptible rats.
- Determine relative toxicity of coal combustion and ambient PM_{2.5} (CAPs).
- Determine the effect of atmospheric conditions on secondary PM formation/toxicity.

Project Organization

- EPRI Project Manager: Annette Rohr
- Contractors:
 - Exposure Characterization/Atmospheric Aging: Petros Koutrakis, Harvard
 - Toxicology: John Godleski, Harvard
- Technical Advisory Committee:
 - Joe Mauderly, LTRI
 - Bruce Miller, Penn State
 - Ken Sexton, UNC

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Motivation for Research

- Although it is important to understand the toxicity of primary coal fly ash because it is enriched in trace metals, very low quantities of this material are emitted from power plants in the U.S. since all coal-fired utility boilers utilize some type of PM control (e.g., ESPs generally remove 99%+ of PM).
- Populations are exposed primarily to *secondary* PM, for which we have no direct, source-related toxicological information.
- Also, direct inhalation exposures to actual plant emissions have not been done.
 - Some studies have used CFA samples collected from plants, but these were instilled into animals – doses tend to be high. There are also potential issues related to changes in PM characteristics during storage.
 - Some studies have used pilot combustors: emissions from pilot combustors may differ from full-scale plants due to differences in surface area/volume ratios and therefore time-temperature histories.

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Process of Research Design

- Our goal was to assess the toxicity of coal combustion emissions to complement our ongoing epidemiological research.
- Importantly, we wanted to do this in a realistic manner.
- We considered the use of a pilot combustor. Several issues resulted in us reconsidering this plan:
 - Pilot combustor emissions are not identical to full-scale plants.
 - Our advisors were not supportive of the use of pilot combustors.
- We also wanted to determine the relative toxicity of coal combustion vs. ambient $PM_{2.5}$ – thus, the generation of realistic atmospheres was of critical importance.
- The end result was our decision to move on-site and utilize mobile chemical and toxicological laboratories to allow “artificial aging” of emissions.

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Obtaining Host Sites

- Task appeared slightly daunting since many companies may not be amenable to animal experiments being associated with their facilities.
- This has not been as difficult as we thought. Permission for the first plant has led to several expressions of interest from other companies.
- Stipulations: plant retains anonymity and in publications is referred to only in a generic manner (e.g. “medium-output plant in the Upper Midwest utilizing low sulfur coal”).

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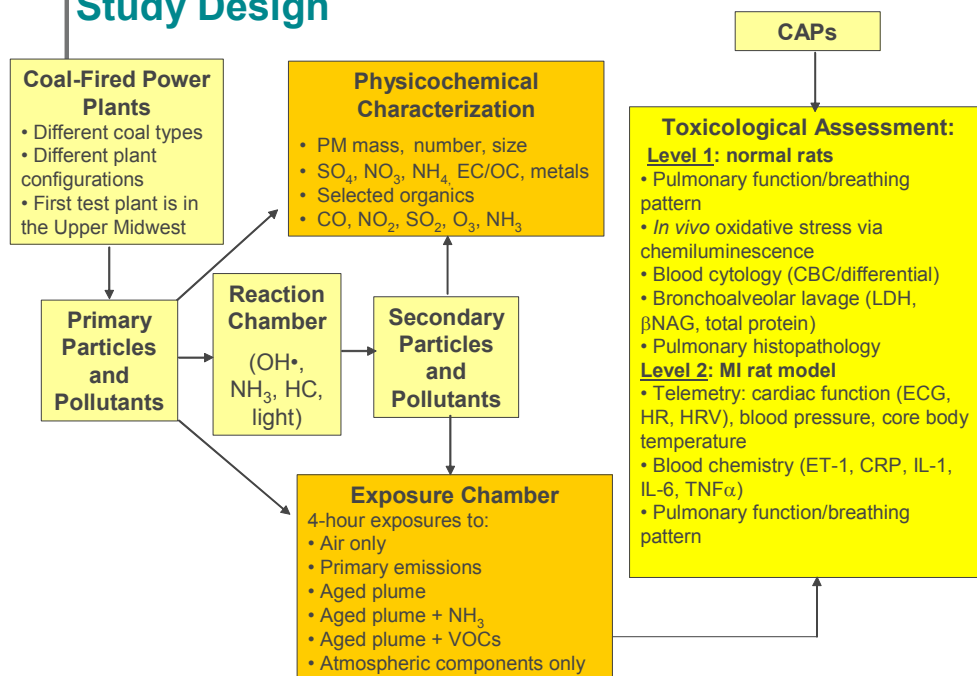
Planned Host Sites

- Site 1 (confirmed for Fall 2003):
 - Upper Midwest plant utilizing Power River Basin coal.
 - 2 units: ESPs on both units, SCR on one unit, other SCR currently under construction.
- Site 2 (planned):
 - Midwest plant utilizing medium-to-high sulfur eastern bituminous coal.
 - 1 unit: ESP, no scrubbers or SCRs.
- Site 3 (planned):
 - Southeastern U.S. plant utilizing high sulfur eastern bituminous coal.
 - Ideally would have scrubber.
- SCR not deemed as important since for NO_x control, although higher SO₃ can result.

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Study Design



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TERESA: Project Objectives

- 1 Investigate the toxicity of coal combustion emissions by utilizing realistic exposures that consider secondary chemistry.
- 2 Investigate the effect of atmospheric conditions and aging on secondary particle formation and toxicity.
- 3 Provide insight into toxicological mechanisms of PM-induced effects, particularly as they relate to susceptible subpopulations.
- 4 Compare the toxicity of coal combustion emissions with secondary mobile source emissions and ambient PM.

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TERESA: Status

- Design of sampling system, photochemical chamber, mobile laboratories is underway.
- Laboratory testing of a prototype photochemical chamber with SO₂ and NO_x nearing completion.
- Fieldwork at first host site scheduled for early fall 2003.

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Comparison with NERC Program

- Very different objectives.
- Acute exposures vs. chronic exposures.
- Field-based vs. laboratory-based.
- Significantly less extensive toxicological assessment, in terms of both the number of endpoints and the variety of systems investigated.

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Possible Synergies with NERC Program

- TERESA can provide input/insight into planning for NERC coal atmosphere, e.g. atmospheric aging methods.
- TERESA includes extensive chemical characterization of emissions which will enable comparison to NERC atmosphere.
- In the case of an engineered NERC atmosphere, possible use of fly ash from a TERESA plant to allow more direct comparison. This was discussed at the NERC Coal Workshop in February and EPRI has offered assistance in obtaining such fly ashes.
- Use of a common *in vitro* assay (e.g. oxidant potential) in both studies, again as a point of comparison.

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